Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

[An Autonomous Institution, affiliated to VTU, Belgaum and Aided by Government of Karnataka]

Near Jnana Bharathi Campus, Mallathalli, Bangalore-560056

DEPARTMENT OF MECHANICAL ENGINEERING

Master of Technology

in

Robotics and Artificial Intelligence

SYLLABUS & SCHEME

2025 - 2026

Dr.Ambedkar Institute of Technology
Scheme of Teaching and Examinations – 2024
M.Tech, Robotics and Artificial Intelligence (RAI)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

FIRST SEMESTER

Sl. No.	Course	Course Code	Course/Subject Title	Teaching hours per week			Maximum Marks Allotted				Examination Credits
				Lecture	Practical/ Project/ Seminar	Tutorial/ Skill Development Activity T/SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	BSC	MRAI101	Mathematical Methods in Engineering	03	00	02	03	50	50	100	**3**
2	IPCC	MRAI102	Applied Mechatronics	03	02	00	03	50	50	100	**4**
3	PCC	MRAI103	Robotics- Analysis & Control	03	00	02	03	50	50	100	**3**
4	PEC	MRAI114	Professional Elective I	03	00	00	03	50	50	100	**3**
5	PEC	MRAI115	Professional Elective II	03	00	00	03	50	50	100	**3**
6	PCCL	MRAIL06	Advanced Python Programming Lab	00	02	02	03	50	50	100	**2**
7	NCMC	MRM107	Research Methodology and IPR	ONLINE COURSES (online.vtu.ac.in)							**PP**
			TOTAL	**15**	**04**	**06**	**18**	**300**	**300**	**600**	**18**

PROFESSIONAL ELECTIVE-1

Sl. No	Subject Code	Subject title
1	MRAI114A	Soft Computing
2	MRAI114B	Computer Aided Design
3	MRAI114C	Internet of Things for Robots

PROFESSIONAL ELECTIVE-II

Sl. No	Subject Code	Subject title
1	MRAI115A	Robot System Design
2	MRAI115B	Sensors and Actuators for Robotics
3	MRAI115C	Additive Manufacturing

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, NCMC - Non Credit Mandatory Course,

AUD/AEC –Audit Course / Ability Enhancement Course(A pass in AUD/AEC is mandatory for the award of the degree), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

Integrated Professional Core Course (IPCC): **Integrated Professional Core Course (IPCC)**: Refers to Professional Theory Core Course Integrated with practical of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Audit Courses /Ability Enhancement Courses Suggested by BoS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

Ability Enhancement Courses:

● These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialisation as well allied fields that leads to employable skills. Involving in learning such courses is impetus to lifelong learning.

● The courses under this category are online courses published in advance and approved by the concerned Board of Studies.

● Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.

● In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.

● The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).

2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.

3. Involve in case studies and field visits/ fieldwork.

4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.

5. Handle advanced instruments to enhance technical talent.

6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.

7. Work on different software/s (tools) to simulate, analyse and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

SECOND SEMESTER

Sl. No.	Course	Course Code	Course/Subject Title	Teaching hours per week				Maximum Marksallotted			Examination Credits
				Lecture	Practical/ Project/ Seminar	Tutorial/ Skill Development Activity	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	MRAI201	Control & Embedded System Engineering	02	00	02	03	50	50	100	**03**
2	IPCC	MRAI202	Advanced Java Programming	03	02	00	03	50	50	100	**04**
3	PEC	MRAI213	Professional Elective III	02	00	02	03	50	50	100	**03**
4	PEC	MRAI214	Professional Elective IV	02	00	02	03	50	50	100	**03**
5	MPS	MRAIM25	Mini Project with Seminar	00	04	02	--	100	--	100	**03**
6	PCCL	MRAIL206	Autonomous Vehicles & AI Laboratory	01	02	00	03	50	50	100	**02**
7	AUD/AEC	22AUD27	Suggested ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							**02**
TOTAL				**10**	**08**	**08**	**15**	**350**	**250**	**600**	**20**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project With Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab, L-Lecture, P-Practical, T/SDA-

Tutorial / Skill Development Activities(Hours are for Interaction between faculty and students)

PROFESSIONAL ELECTIVE- III **PROFESSIONAL ELECTIVE-IV**

Sl. No	Subject Code	Subject title	Sl. No	Subject Code	Subject title
1	MRAI213A	Computer Numerical Control (CNC) Machines and Adaptive Control	1	MRAI214A	Industrial Automation
2	MRAI213B	Signal Processing	**2**	MRAI214B	Machines & Mechanisms
3	MRAI213C	Computer Integrated Manufacturing	**3**	MRAI214C	Algorithms & Complexity

THIRD SEMESTER

Sl. No.	Course	Course Code	Course/Subject Title	Teaching hours per week				Maximum Marksallotted			Examination Credits
				Lecture	Practical / Project/ Seminar	Tutorial/ Skill Development Activity	Duration in hours	CIE	SEE	Total	
1	INT	MRAI301	Internship					50	50	100	08
2	GP	MRAI302	Group Project					50	50	100	12
3	PROJ	MRAI303	Project Phase - 1					50	50	100	02
TOTAL								**150**	**150**	**300**	**22**

Note: AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), INT- Internship, GP-Group Project, PROJ-Project work

Note:

1. Internship: All the students shall have to undergo a mandatory internship of 10 **weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in the internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

2. Group Project: Group of four students shall carry out the project work . A examination shall be conducted during III semester and the prescribed The candidates should be able to effectively, orally present a seminar on the project work executed during the III semester . The same shall be evaluated by a panel of examiners recommended by the department.

3. Project Phase I: During the III Semester, through literature survey and discussion with the supervisor allotted by the department, the candidate would have formulated a research problem and the candidate shall prepare a project report in bound form and submit the same to the department, with due certification by the supervisor.

FOURTH SEMESTER

Sl. No.	Course	Course Code	Course/Subject Title	Teaching hours per week				Maximum Marksallotted			Examination Credits
				Lecture	Practical / Project/ Seminar	Tutorial/ Skill Development Activity	Duration in hours	CIE	SEE	Total	
1.	PROJ	MRAI401	Project Phase - II					**50**	**50**	**100**	20
TOTAL								**50**	**50**	**100**	**20**

Note: PROJ-Project work

Note:

1. **Project Phase II:** During the IV Semester, The candidate should be able to effectively, orally present a seminar on the project work executed during the III and IV semesters. The same shall be evaluated by a panel of examiners recommended by the department.During the Phase II, based on the problem formulation, experimentation will be carried out using a suitable methodology, followed by results and discussion. As a last part of the project work, in Phase II, the candidate shall prepare a project report in bound form and submit the same to the department, with due certification by the supervisor.

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: FIRST

COURSE TITLE: MATHEMATICAL METHODS IN ENGINEERING		
Sub Code: MRAI101	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

This course will enable students to

1. Know how to Model and Solve, Ordinary Differential Equations of First and Second Order.
2. Understand Linear Algebra and its Applications.
3. Apply the Calculus of Variation for Engineering Applications
4. Use the Methods of Complex Analysis for Engineering

#	CONTENTS	Hrs
UNIT-1	**Modelling with First Order Differential Equations:** Introduction, Differential Equations as a Mathematical Model, Fundamentals of Differential Equations, Variables separable, Motion of a Falling Body (Falling Bodies and Air Resistance), Newton's law of cooling, Heat flows in Solids by conduction and Heat Transfer in Solids Submerged in Fluid. **Second-Order Linear ODEs:** Homogeneous Linear ODEs with Constant Coefficients, Modeling of Free Oscillations of a Mass–Spring System, Non-homogeneous ODEs, Modeling: Forced Oscillations.	**9**
UNIT-2	**Partial Differential Equations:** Basic Concepts of PDEs, Modeling: Vibrating String (Wave Equation), Solution by Separating Variables, D'Alembert's Solution of the Wave Equation and Characteristics, Modeling: Heat Flow from a Body in Space (Heat Equation), Heat Equation: Solution by Fourier Series.	**9**
UNIT-3	**Linear Algebra**: Matrices, Vectors, Matrix Multiplication, Linear Independence. Vector Space, Rank of a Matrix. Solutions of Linear Systems: Gauss Elimination and Gauss–Jordan Methods, Some Applications of Eigenvalue and Eigenvectors problems by Rayleigh power method	**7**
UNIT-4	**Complex Numbers:** Functions and Differentiation: Geometric Representation, Polar Form of Complex Numbers, Powers and Roots, Analytic Function, Cauchy–Riemann Equations, Exponential Function, Trigonometric and Hyperbolic Functions.	**8**
UNIT-5	**Calculus of Variation:** Introduction, Examples of Simple Functionals, The first Variation (Euler - Lagrange Equation), Brachistochrone problem. Isoperimetric problems. Rayleigh Ritz method -problems.	**7**

TEXT BOOKS

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons.
2. Door Irving Herman Shames, Clive L. Dym , "Energy and Finite Element Methods in Structural Mechanics", 1st Edition, 2015 Reprint, New Age International.

Web links and Video Lectures (e-Resources):

1. Differential Equations for Engineers https://archive.nptel.ac.in/courses/111/106/111106100/

Ordinary and Partial Differential Equations and Applications

https://onlinecourses.nptel.ac.in/noc22_ma02/preview

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Solve ordinary differential equation and system of linear equations.
CO2	Test consistency of partial differential equation and applications
CO3	Describe Model and find the solutions for Linear Algebra
CO4	Identify the mathematical techniques of complex numbers.
CO5	Solve the mathematical Functionals

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026
SEMESTER: FIRST

COURSE TITLE: APPLIED MECHATRONICS		
Sub Code: MRAI102	**No of Credits : L-T-P-SS 3:0:2:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. Students will be able to enumerate and illustrate elements of mechatronics Systems, its evolution and the underlying multidisciplinary nature of the course.
2. For a given problem description, students will be able to select the appropriate sensors, actuators, signal conditioning elements, Microprocessors and control system.
3. For a given case study/application, Students will be able to independently analyze the mechatronics system and demonstrate the troubleshooting of the mechatronics system using fault finding techniques
4. For the given industrial application, students will be able to design and simulate pneumatic/electro-pneumatic circuits and PLC programs using modern tools/software.
5. Students will be able to identify the components of pneumatic/electro-pneumatic, PLC systems and practically execute them on appropriate workstations.

#	CONTENTS	Hrs
UNIT-1	**Introduction of Mechatronic systems:** Evolution of Mechatronic Systems, Sequential & Concurrent Engineering, Elements of Measurement System. Open and closed loop systems, concepts of feedback, requirement of an ideal control system. **Mathematical Models-**Review of Laplace Transforms, Transfer Function Derivation, Models of Mechanical Systems-Linear & Rotary (Spring-Mass-Damper), Mathematical Models of RLC electrical circuits, Analogous Systems	**9**
UNIT-2	**Transducers & Sensors:** Sensors/Transducers, Performance Terminologies, Displacement, Position & Proximity, Velocity & Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors, **Actuation systems:** Electrical systems, Mechanical switches, Relays, solenoids, DC & AC motors, Stepper motors, Series Elastic Actuators and their merits and demerits, Pneumatic Actuators-Symbols, Valves, Cylinders, FRL Unit, Compressors, Hydraulic Actuators-Powerpack, Mathematical models of DC motors and Rotational- Translational Systems	**9**
UNIT-3	**Signals & Signal Conditioning:** Introduction to Digital & Analog Signals, Their Merits & Demerits**,** Introduction to signal conditioning. The operational amplifier, Protection, Filtering and Digital Signals, ADC, DAC, Multiplexers, Data acquisition, Pulse-modulation. **Programmable Logic Controllers (PLC)** Introduction to PLC, Principles of Operation; Various Parts of a PLC: CPU & programmer/ monitors; PLC input & output modules; I/O modules; power supplies. PLC advantage & disadvantage; PLC versus Computers.	**7**

UNIT-4	**Microprocessors** Basic Elements of a Microprocessor: CPU, ALU, Memory, I/O Ports, Bus, Read & Write Cycle. Overview of Architecture of 8085 Microprocessor, Timing & Control Units. **Introduction to Single Board Computers (SBC):** Overview of Raspberry Pi Board, NVIDA TEGRA, UDOO, Microprocessors Power Supply, Memory, Ports, GPIOs, setting up the Raspberry Pi (Including Headless Setup), Installing Raspbian, Overview of Raspbian OS, Linux terminal commands for navigation.	**8**
UNIT-5	**Fault Finding** Fault Finding Techniques, watchdog Timer, Parity & Error Coding Checks, Common Hardware Faults, Emulation & Simulation **Application Case Studies** Windscreen Wiper Motion, Bathroom Scales, Pick & Place Robot, Car Park Barriers, Digital Camera, Car Engine Management, Bar Code Reader, Hard Disk Drive,	**7**

Practical Component of IPCC

SI. NO.	Experiments
Pneumatics	
1	Marking Machine
2	Clamping Camera Housing
Electro-Pneumatics	
1	Clamping Device
2	Rotary Indexing Table
Programmable Logic Controllers (PLC)	
1	Sequential Motor ON controller
2	Control of Single/Double Acting Cylinder
3	Sequential Control of Multiple Actuators (A+,B+,A-,B-), (A+,B B+,A-), (A+,A-,B+, B-)

Textbook/ Textbooks

(1) Mechatronics-Electronic Control Systems in Mechanical & Electrical Engineering By W. Bolton, Pearson Publication (2014)

(2)

Reference Books

(1) Raspberry Pi Official Documentation

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_me27/preview
  https://www.raspberrypi.com/documentation/

Skill Development Activities (SDA) Suggested:

Mathematical Model Simulation: Mechanical & Electrical System Simulation using SIMULINK (MATLAB)

Demonstration of Raspberry Pi: Interfacing the LED, Buzzer and Input Switches to GPIOs of Raspberry Pi and Programming them using Python.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Understand the fundamentals of mechatronic systems and analyze the role of feedback and control in system performance.
CO2	Develop and interpret mathematical models of mechanical and electrical systems using

	Laplace transforms and analogous system concepts.
CO3	Identify and evaluate suitable sensors, transducers, and actuators for various industrial and automation applications.
CO4	Explain signal conditioning processes and implement data acquisition using ADCs, DACs, multiplexers, and microcontroller interfaces.
CO5	Design simple automation systems using PLCs and microprocessors, and demonstrate fault finding techniques in mechatronic applications.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026
SEMESTER: FIRST

COURSE TITLE: ROBOTICS -ANALYSIS & CONTROL		
Sub Code: MRAI103	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. Identify the various configurations of robots, their anatomy and transformation matrices
2. Given an industrial manipulator, students will be able to analyse the kinematics by applying DH Parameters and enumerate the principles of statics associated with them
3. Students will be able to analyze the dynamics of manipulators by deriving the equation of motions
4. Students will be able to elucidate the issues associated with mobile robots such as its kinematics, localization, obstacle avoidance, sensing and perception Students will be able to enumerate the various motion control techniques and application of AI for robots.

#	CONTENTS	Hrs
UNIT-1	**Serial Linkage Robots:** Laws of Robotics, classification of serial manipulator, Anatomy of Robot, Gripper mechanisms, Automation and Robotics, Notation, Position and Orientation of a Rigid Body, Representation of a pure rotation about an axis. Some Properties of Rotation Matrices, Successive Rotations, Euler Angles For fixed frames X-Y-Z and moving frame ZYZ. Transformation between coordinate system, Homogeneous coordinates. Robot Design Process.	**9**
UNIT-2	**Kinematics of serial manipulators**: Representation of Links using Denvit- Hartenberg Parameters, Link transformation matrices, Transformation matrices of 3R manipulator, PUMA560 manipulator, SCARA manipulator. Direct kinematics of 2R, manipulator, Inverse kinematics of manipulator. Velocity and **Statics of Manipulators**: Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, 2R manipulators, Jacobian of serial manipulator, Velocity ellipse of 2R manipulator, Singularities of 2R manipulator, Statics of serial manipulators	**9**
UNIT-3	**Dynamics of Manipulators:** Kinetic energy, Potential energy, Equation of motion using Lagrangian, Equation of motions of one- and two-degree freedom spring mass damper systems using Lagrangian formulation, Inertia of a link, Recursive formulation of Dynamics using Newton Euler equation, Equation of motion of 2R manipulator using Lagrangian, Newton- Euler formulation.	**7**
UNIT-4	**Mobile Robotics** Classification, Key Issues in Locomotion using Legged and Wheeled Robots, Mobile Robot Kinematics, Mobile Robot Manoeuvrability, Mobile Robot Workspace, Motion Control, Sensors for Mobile Robots. Mobile Robot Localization Techniques, Path Planning & Obstacle Avoidance, Navigation Architectures **Sensing and Perception** Perception Process, Force and Tactile Sensors, Inertial Sensors, GPS, and Odometry, Sonar Sensing, Multisensor Data Fusion Methods, Multisensor Fusion Architectures,	**8**

	Applications	
UNIT-5	**Motion Control** Joint Space Versus Operational Space Control, Independent-Joint Control, PID Control, Tracking Control, Computed-Torque Control, Adaptive Control, Optimal and Robust Control, Digital Implementation, Learning Control. **AI Reasoning Methods for Robotics:** Knowledge Representation and Inference, KR Issues for Robots, Action Planning, Robot Learning	**7**

Textbooks

1. ***Introduction to Robotics, Analysis, Control, Applications*** by Niku S B, Wiley Publication (2011)
2. ***Handbook of Robotics*** **Compiled by Bruno Siciliano, Oussama Khatib Published by Springer (2008)**

Reference Books

1. ***Fundamentals of Robotics, Analysis and Control*** by Schilling R. J, Published by PHI (2010)
2. **Robotics and Control, by Mittal and Nagrath, Tata Mc Grew Hill Publication**

Web links and Video Lectures (e-Resources):

- **https://nptel.ac.in/courses/112105249**
- **http://www.roboanalyzer.com/**

https://www.robotc.net/

Skill Development Activity (SDA)

- Robot Prototype Design using TETRIX STEM Kits
- Analysis of DH Parameters using Robo Analyzer
- Interface Sensors and Control System for Robots
- Program the robot using Arduino & Robot C
- Solve Open Ended Complex Engineering Problems

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Explain the principles of robot anatomy, laws of robotics, serial manipulator classification, gripper mechanisms, and transformation between coordinate frames using rotation matrices and Euler angles.
CO2	Model the kinematics of serial manipulators using Denavit-Hartenberg parameters and compute forward and inverse kinematics for various robot configurations like 2R, PUMA 560, and SCARA manipulators.
CO3	Analyze the velocity and statics of manipulators using Jacobian, identify singularities, and evaluate dynamic behavior using Lagrangian and Newton-Euler methods for 2R and multi-link manipulators.
CO4	Describe mobile robot locomotion, sensing techniques, localization, path planning, and navigation architectures for both wheeled and legged robots.
CO5	Design and evaluate robot control systems using PID, adaptive, and robust control strategies, and demonstrate AI-based reasoning methods such as knowledge representation, learning, and action planning.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026
SEMESTER: FIRST

COURSE TITLE: SOFT COMPUTING		
Sub Code: MRAI114A	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. To understand the fundamental principles of Artificial Neural Networks (ANN), Fuzzy Logic, and Genetic Algorithms, including their structures, operations, and real-world significance.
2. To explore supervised learning techniques such as Perceptron, ADALINE, MADALINE, and Backpropagation, and apply them in classification and prediction tasks.
3. To develop a strong foundation in fuzzy set theory and fuzzy relations**,** including fuzzification, membership functions, and decision-making using fuzzy logic.
4. To apply defuzzification methods and fuzzy decision-making strategies for solving complex, uncertain, or imprecise real-world problems in engineering and computing.
5. To implement Genetic Algorithms and Genetic Programming techniques for optimization and search applications, and understand their integration in hybrid intelligent systems.

#	CONTENTS	Hrs
UNIT-1	Introduction: Neural networks, Fuzzy logic, Genetic algorithms, Hybrid systems, Artificial Neural Networks: Fundamental concept, Evolution, Basic model of ANN, Important terminologies of ANN, MP neuron, Hebb Network.	**8**
UNIT-2	Supervised Learning Network: Perceptron Networks, Adaptive linear neuron, multiple adaptive linear neurons, Back propagation Network	**8**
UNIT-3	Introduction to Fuzzy logic, classical sets and fuzzy sets: Classical sets, Fuzzy sets. Classical relations and fuzzy relations: Cartesian product of relation, Classical relation, Fuzzy relations, Tolerance and equivalence relations. Membership functions: Features, Fuzzification, methods of membership value assignments.	**8**
UNIT-4	Defuzzification: Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations, Defuzzification methods.Fuzzy decision making: Individual, multiperson, multiobjective, multiattibute, and fuzzy Bayesian decision making.	**8**
UNIT-5	Genetic algorithms: Introduction, Basic operations, Traditional algorithms, Simple GA, General genetic algorithms, The schema theorem, Genetic programming, applications.	**8**

Text Book:

1. Principles of Soft computing, S N Sivanandam, Deepa S. N, Wiley, India, (Chapters 1, 2, 3(Up to 3.5), 7, 8, 9, 10, 13, 15 (up to 15.6 & 15.9,15,10)

Reference Book:

1. Neuro-fuzzy and soft computing, J.S.R. JANG, C.T. SUN, E. MIZUTANI, PHI (EEE edition) ISBN: 978-81-203-2243-1

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Identify and describe soft computing techniques and their roles in building intelligent machine.
CO2	Identify the components and building block hypothesis of Genetic algorithm
CO3	Examine the features of neural network and its applications.
CO4	Design Genetic algorithm to solve optimization problem.
CO5	Describe Neuro-Fuzzy system for clustering and classification and Recognize the feasibility of applying a soft computing methodology for a particular problem

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: FIRST

COURSE TITLE: COMPUTER AIDED DESIGN		
Sub Code: MRAI114B	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. To introduce the fundamental concepts of CAD/CAM and their role in the product development cycle, automation, computer graphics, and CAD system hardware.

2. To enable understanding of CAD software configuration and interfaces, including database structures, graphic transformations, plotting techniques, and the use of cloud-based CAD/CAM tools.

3. To develop the ability to perform geometric transformations in 2D and 3D, including display systems, windowing, clipping, and mathematical operations for graphic manipulation.

4. To provide a comprehensive understanding of geometric and surface modelling, including wireframe, solid, parametric representations of curves and surfaces (analytic and synthetic forms).

5. To explore the application of CAD in mechanical assemblies and robotics, including curve segmentation, intersection, and the interpretation of mating conditions and real-world case studies.

#	CONTENTS	Hrs
UNIT-1	**Introduction to CAD:** Definition, Product cycle and CAD/CAM, Automation & CAD/CAM Computer Graphics and Database: Introduction, Software configuration of a Graphic system, Functions of graphics package, Constructing the Geometry, Database structure and Content, Wire frame features. Computer Aided Design System Hardware Introduction, Generative design, topology optimization.	**8**
UNIT-2	**Graphic Interface and CAD/CAM Cloud:** CAD System Configuration, Computer Aided System Software: Introduction, Operating system, Graphics system. Graphics Database structure and Handling, Data Selection, Graphic transformation, Plotting, Graphic standards. Cloud Based CAD/CAM tools.	**8**
UNIT-3	**Transformation Systems:** Display, Windowing and Clipping, Two-dimensional transformations, Three-dimensional transformations, linear transformations, problems on Two-dimensional Transformations	**8**
UNIT-4	**Geometric Modelling - Introduction:** Dimensions of models, Types of models, Construction of solid models, Wire frame models, Curve representation. Parametric representation of analytic curves – Lines, Circles, Ellipse, Parabolas, Hyperbolas, Conics. Parametric representation of Synthetic Curves – Hermite Cubic Splines, Bezier Curves, B-Spline Curves, Rotational Curves. Surface Models: Introduction – Surface models, Surface Entities, Surface Representation. Parametric Representation of Analytic Surface – Plane surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Parametric representation of Synthetic surface, Bezier Surface, B-Spline surface, Coons Surface.	**8**

UNIT-5	**Interpretation & Applications of CAD in Robotics:** Curve Segmentation, Trimming, Intersection & Projection. Mechanical Assembly: Introduction, Assembly modelling – Parts modelling and Representation, Hierarchical Relationship, Mating Conditions. Inference of position from mating conditions. Versatility of Applications of CAD in robotics – Case Studies.	**8**

Text Books:

1. M P Groover and Zimmer, CAD/CAM Computer Aided Design and Manufacturing, Prentice hall 2000.
2. CAD/CAM Ravindra A.S Best Publishers 2005.

Reference Books:

1. C B Besant and CWK Lui – Computer Aided Design and Manufacturing, Affiliated East West, India 1988.
2. Ibrahim Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill 1988.

Web Links and E Resources:

1. https://nptel.ac.in/courses/112102101
2. https://nptel.ac.in/courses/106102065
3. https://www.digimat.in/nptel/courses/video/111104095/L01.html
4. https://nptel.ac.in/courses/107103012
5. https://archive.nptel.ac.in/courses/107/103/107103012/

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Demonstrate basics of product cycle, CAD system software and hardware, CAD Database, graphic standards, Mechanical assembly and inferences to be drawn from an assembly.
CO2	Illustrate basics of graphic transformations and graphic representations and exhibit the knowledge of working on a CAD user interface
CO3	Solve math based problems using graphic transformation and graphic representation.
CO4	Analyze the geometrical entities with respect to their parametric representation.
CO5	Demonstration and application of principlles of CAD in robotics

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: FIRST

COURSE TITLE: INTERNET OF THINGS FOR ROBOTS		
Sub Code: MRAI114C	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. To introduce the foundational concepts and architecture of the Internet of Things (IoT),
2. To explore the role of smart objects and sensors in robotics, focusing on their communication technologies, access methods, and relevant IoT protocols for seamless data transmission and control.
3. To enable students to design and prototype IoT-enabled robotic systems
4. To examine the current trends and future directions of Internet of Robotic Things (IoRT),
5. To study real-world applications of IoT in manufacturing and autonomous systems, covering human-computer interaction

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION:** Technology of the IoT and applications,. IoT data management requirements, Architecture of IoT, Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things. **DESIGN OF IoT :** Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.	**9**
UNIT-2	**SMART OBJECTS OF ROBOT:** The "Things" in robot, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies. Application Protocols for IoT	**8**
UNIT-3	**PROTOTYPING OF IoT ROBOT :** Design principles for connected devices -Embedded devices, physical design, online components. Informed Manufacturing plant – Elements, IoT implementation in Transportation and logistics robot, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Energy management and resource optimization, proactive maintenance. IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking)for robot.	**9**
UNIT-4	**INTERNET OF ROBOTIC THINGS:** Current Technologies, cloud robotics, Space and defence applications, Challenges and Future Directions.	**7**

UNIT-5	**APPLICATION IN MANUFACTURING :** Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges	**7**

References Books:

1. Adrian McEwan and Hakim Cassimally, "Designing the internet of things", Wiley, 2013
2. Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business, by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley &Sons.
3. Internet of Things: A Hands-On Approach by Vijay Madisetti, Arshdeep Bahga, VPT; 1st edition 2014.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine-to-Machine to the Internet of Things -Introduction to a New Age of Intelligence" Elsevier
5. Meta Products -Building the Internet of Things by Wimer Hazenberg, Menno Huisman, BIS Publishers 2014.
6. Carlos, Bruno, Georges Bastin, "Theory of Robot Control", Springer, 2012
7. R Kelly, D. Santibanez, LP Victor and Julio Antonio, "Control of Robot Manipulators in Joint Space", Springer, 2005.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Position to understand various building blocks and working of state-of-the-art IoT systems.
CO2	Gain better knowledge about wireless technology and control system.
CO3	Easy management of robot resources for particular application by using suitable sensors and IoT from anywhere.
CO4	Students would also gain enough insights to conceive and build IoT robots on their own**.**
CO5	The typical use cases of IoT robots are wearables, smart homes, smart vehicles, traffic prediction & control weather monitoring & forecasting, indoor location-based services, health monitoring of machines & structures.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

1. Two full questions (each of 20 Marks) are to be set from each unit.
2. Student shall answer five full questions selecting one full question from each unit.

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: FIRST

COURSE TITLE: ROBOT SYSTEM DESIGN		
Sub Code: MRAI115A	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. To introduce the fundamental principles and phases of mechanical design, including the role of design engineers,
2. To understand and apply stress and strain concepts, including Hooke's law, true stress-strain, elastic constants, and behavior of materials (ductile, brittle, composite, etc.) under mechanical loads.
3. To perform stress and strain analysis in straight, stepped, and tapered members, and compute shear stress, lateral strain, and use Poisson's ratio and related elastic constants in design calculations.
4. To analyze failure under static loading conditions using elastic failure theories such as maximum normal stress, maximum shear stress, and distortion energy theories,
5. To study the design and performance of mechanical power transmission systems, including spur gears, gear trains, and belt drives.

#	CONTENTS	Hrs
UNIT-1	**Introduction:** Introduction to Mechanical Engineering Design, phases of design process, design consideration, design tools and resources, design engineers responsibilities, codes and standards, safety and product liability, stress and strength, design factor and factor of safety, reliability. **Materials:** Material strength and stiffness, Stress, Strain and Hooke‟s law, Stress strain diagram for brittle and ductile materials, Factor of safety, True stress and strain, hardness, ferrous, non-ferrous, plastics and composite materials.	**9**
UNIT-2	**Design Calculation –** Calculation of stresses in straight, Stepped and tapered sections, Shear stress and strain, Lateral strain and Poisson‟s ratio, Elastic constants and relations between them.	**8**
UNIT-3	Static Strength, Static loads, Theories of elastic failure – Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials, Stress concentration factor	**7**
UNIT-4	**Spur Gears** – Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. **Gear Trains** – Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains	**9**

UNIT-5	**Belt Drives –** Belt Drives, types – flat and v belt, materials, ratio of tensions, centrifugal stress in a belt, Power transmitted, effect of centrifugal tension on power transmitted, Simple numerical problems	**7**

Text Book:

1. Shigley's Mechanical Engineering Design, McGraw-Hill Series in Mechanical Engineering - Richard Budynas, Keith Nisbett, ISBN - 9780073398204, Publisher - McGraw-Hill Education.

Reference Book:

1. Design of Machine Elements, V B Bhandari, Fifth Edition, ISBN - 978-9390177479, Publisher, McGraw Hill

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Selection of suitable materials for robotic applications.
CO2	Establish design calculations for straight and tapered bars.
CO3	Identify the failure of a ductile and brittle materials.
CO4	Establish the parameters in design of spur gear.
CO5	Select suitable belt drives for power transmission.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

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QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: FIRST

COURSE TITLE: SENSORS AND ACTUATORS FOR ROBOTICS		
Sub Code: MRAI115B	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. To introduce the principles and industrial applications of photodetectors and proximity sensors, including beam, reflex, inductive, capacitive, microwave, and laser-based detection methods in manufacturing systems.

2. To explore advanced sensor technologies for component identification and process monitoring, including barcodes, transponders, surface acoustic waves, and fuzzy logic-based optoelectronic color sensors.

3. To analyze the role of vision and multi-sensor systems in Flexible Manufacturing Systems (FMS), including visual sensing tasks, edge detection, image processing, and monitoring in extreme manufacturing conditions.

4. To provide an in-depth understanding of different types of actuators—pneumatic, electro-pneumatic, hydraulic, and electric—along with their construction, characteristics, selection criteria, and applications in automation and control systems.

5. To understand the application of fiber optics in industrial sensing and control, including sensor alignment, long-distance detection, communication principles, and system configuration for enhanced precision and flexibility in manufacturing environments.

#	CONTENTS	Hrs
UNIT-1	**Introduction:** Manufacturing applications of photo detectors, detection methods through beam detection, Reflex detection & Proximity detection. Applications of inductive and capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches.	**9**
UNIT-2	**Advanced sensor technology** Identification of manufacturing components, bar code, transponder, electro-magnetic identifier, surface acoustic waves, optical character recognition, and fuzzy logic for opt-electronic colour sensor in manufacturing, Sensing principles, colour theory, unit colour measurement, colour comparator, colour sensing algorithm, design in fuzzy logic colour sensor.	**8**
UNIT-3	**Sensors in FMS** Vision sensors, image transformations, robot visual sensing tasks, edge detection & extraction, Detecting partially visible objects, cryogenic manufacturing applications,	**7**

	measurement of high temperature, multi sensor, control robot assembly, collection & generation of process signals in decentralized manufacturing system	
UNIT-4	**Actuators - Introduction:** Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator	**9**
UNIT-5	**Fiber Optics in sensors and control systems** Introduction, Photoelectric sensors-long-distance detection, Fiber optics, types of fiber optics, optical fiber parameters, factors affecting the selection of position sensors, sensor alignment techniques, principal of fiber optics in communication, configuration of fiber optics, flexibility and testing of fiber optics, applications of fiber optics.	**7**

Text Books:

1. Sabne soloman, sensors & control systems in manufacturing. Mc-Graw Hill book Company Network, 1994.
2. N.L.Buck & T.G.Buckwith, Mechanical measurement, Addison Wesley Publishing Co.1973.

References Books:

1. Doebelin, Measurement systems: Applications & design, International Student Edition, 1974

Web Links and E Resources:

1. https://archive.nptel.ac.in/courses/108/108/108108147/

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	To analyze the need for applications and advancements with the use of sensors and Control systems.
CO2	To analyze the concept of advanced sensor technology consisting of the newer technologies and components used for identification of manufacturing components, like bar code, transponders, color sensing, etc.
CO3	To apply the advanced techniques of sensors in flexible manufacturing system, such as image transformation, robot visual sensing tasks, detecting partially visible objects, robot assembly control etc
CO4	To analyze the working of various types of actuators.
CO5	To analyze the concepts of fiber optics in sensors and control systems with various industrial applications.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

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QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: FIRST

COURSE TITLE: ADDITIVE MANUFACTURING		
Sub Code: MRAI115C	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. To introduce the fundamentals and classification of additive manufacturing (AM) processes, including the AM workflow, process chain, materials, and distinctions between AM and traditional methods like CNC machining.

2. To understand the role of software in additive manufacturing, including CAD model preparation, STL file issues, manipulation techniques, and the principles of AM technologies like Solid Ground Curing (SGC), LOM, and Binder Jetting.

3. To develop design strategies tailored for additive manufacturing, including design for functionality, printability, anisotropy reduction, topology optimization, and post-processing techniques for both polymers and metals.

4. To explore powder-based AM technologies, such as Selective Laser Sintering (SLS) and Electron Beam Melting (EBM), and understand Directed Energy Deposition (DED) processes with a focus on process parameters, materials, and structure–property relationships.

5. To examine direct and indirect methods for rapid tool production using AM, including metal deposition, casting techniques, and the use of AM for producing patterns, molds, and functional models for manufacturing applications.

#	CONTENTS	Hrs
UNIT-1	**Additive Manufacturing** Additive Manufacturing, The Generic AM Process, AM Information work flow, AM – An Integral Part of Time Compression Engineering, Classification of AM Processes, The Benefits of AM, Distinction Between AM and CNC Machining, Generalized Additive Manufacturing Process Chain. Vat Photopolymerization AM Processes: Introduction, Vat Photo polymerization Materials, Photo polymerization Process, Extrusion-Based Systems: Introduction, Basic Principles, Fused Deposition Modeling from Stratasys, Materials, Limitations of FDM, Bio extrusion	**9**
UNIT-2	**Software** Software Issues for Additive Manufacturing: Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist AM.	**8**

	Solid Ground curing: Introduction, Basic Principles, SGC Process, Materials. LOM, Binder Jetting Solid Porous Tissue Scaffolds by AM, Process Benefits and Drawbacks, Applications	
UNIT-3	**Design For Additive Manufacturing** Design for Additive Manufacturing: Design for Manufacturing and Assembly, Introduction to Design for Additive Manufacturing, General Guidelines for Designing AM Parts, Design to Avoid Anisotropy, Design to Minimize Print Time, Design to Minimize Post-processing. Take Advantage of Design Complexity, Use Topology Optimisation or Lattice Structures, Overhangs and Support Material. **Post-processing:** Support Material Removal., Polymer Surface Treatments, Vapour Smoothing, Painting, Sand Blasting, Hydrographics, Tumbling, Dying, Metal Surface Treatments, Shot- Peening, Plasma Cleaning and Ion Beam Cleaning, Machining and Grinding, Anodizing, Plasma Spraying, Plating and PVD, Gluing and Welding AM Parts,	**9**
UNIT-4	**Powder Bed Process** **Powder Bed Fusion:** Selective Laser Sintering Introduction, Process parameter, sintering in SLS Metal powders for laser sintering, Electron Beam melting (EBM) process. **Directed Energy Deposition Processes:** Introduction, General DED Process Description, Material Delivery, DED Systems, Process Parameters, Typical Materials and Microstructure, Processing– Structure–Properties Relationships, DED Benefits and Drawbacks.	**7**
UNIT-5	**Direct And Indirect Process** Indirect Methods for Rapid Tool Production, Role of Indirect Methods in Tool Production, Metal Deposition Tools, RTV Tools, Epoxy Tools, Ceramic Tools, Cast Metal Tools, Investment Casting, Sand Casting **Direct Methods for Rapid Tool Production:** Classification of Direct Rapid Tool Methods, DTM RapidToo1 process, Sand Form, Injection Moulds, Topographic Shape Formation, Pattern for Investment and Vacuum Casting, Functional Models.	**7**

Text Books:

1. Additive Manufacturing Technologies, I. Gibson l D. W. Rosen l B. Stucker, Springer New York Heidelberg Dordrecht London, 2010.
2. Stereo lithography and other RP & M Technologies, Paul F.Jacobs: "SME, NY 1996.
3. Rapid manufacturing, Fiham D.T & Dinjoy S.S Verlog London 2001.
4. Rapid Prototyping: Principles and Application, by Rafiq I. Noorani

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	The students will learn about a working principle and construction of Additive Manufacturing technology
CO2	The students will potential to support design and manufacturing, modern development in additive manufacturing process.
CO3	The student can assess and implement AM techniques for specific application leading to better ROI for the company that uses Laser AM machines.
CO4	The students can enhance the production sequence of tooling process by choosing the correct material for the job.
CO5	The students are in a position to incorporate the productivity sequence by choosing the right

	AM technology.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: FIRST

COURSE TITLE: ADVANCED PYTHON PROGRAMMING LAB		
Sub Code: MRAI103	**No of Credits : L-T-P-SS 0:0:2:0=2**	**No. of Lecture hours/week :02**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

1. Write a python program to convert the given strings to lowercase letters to uppercase lettersand vice versa.
2. Write a Python program to get a string made of the first 2 and the last 2 chars of a givenstring. If the string length is less than 2, return instead of the empty string.
3. With a given list **L of integers**, write a program to print this list L after removing all duplicatevalues with original order preserved.
4. You are provided with a number **D** containing only digits 0's and 1's. Your aim is to convert this number to have all the digits same.
5. Given a list of **n-1** numbers ranging from **1 to n**, your task is to find the missing number.There are no duplicates.
6. Given a square matrix with **n** rows and **n** columns, you have to write a program to rotate thismatrix such that each element is shifted by one place in a clockwise manner.
7. Given a positive integer number **n**, you have to write a program that generates a dictionary **d** which contains **(i, i*i*i)** such that **i** is the key and **i*i*i** is its value, where **i** isfrom **1 to n (both included)**.
8. Write a program that calculates and prints the value according to the given formula:
9. Write a program that accepts a comma-separated sequence of words as input and prints thewords in a comma-separated sequence after sorting them alphabetically.
10. Write a program, which will find all such numbers between **m** and **n** (both included) such thateach digit of the number is an even number.
11. Write a program that prompts for a file name, then opens that file and reads through the file,and print the contents of the file in upper case.
12. Open the file romeo.txt and read it line by line. For each line, split the line into a list of words using the split() method. The program should build a list of words.
13. Open the file mbox-short.txt and read it line by line. When you find a line that starts with 'From ' like the following line: From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008You will parse the From line using split() and print out the second word in the line .

14. Given a square matrix with **n** rows and **n** columns, you have to write a program to rotate this matrix such that each element is shifted by one place in a clockwise manner.

II SEMESTER

SYLLABUS

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026
SEMESTER: SECOND

COURSE TITLE: CONTROL & EMBEDDED SYSTEM ENGINEERING		
Sub Code: MRAI201	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. Equip the students with the basic concepts of embedded system, applications in which they are used, 8051 micro controller programming concepts.
2. Provide various aspects of embedded system design from Hardware and Software points of view and it describes tools and methodologies needed for embedded system design.
3. Provide RTOS concepts for coding the embedded system software routines. It tells
4. Understand real-time system and describes the characteristics of latency.

#	CONTENTS	Hrs
UNIT-1	**Embedded Design Life Cycle:** Embedded Design life cycle – Product specification – Hardware / Software partitioning – Detailed hardware and software design – Integration – Product testing – Selection Processes – Microprocessor Vs Micro Controller – Performance tools – Bench marking – RTOS Micro Controller – Performance tools – Bench marking – RTOS availability – Tool chain availability – Other issues in selection processes.	**8**
UNIT-2	**Partitioning Decision:** Partitioning decision – Hardware / Software duality – coding Hardware – ASIC revolution – Managing the Risk – Co-verification – execution environment – memory organization – System start-ups – Hardware manipulation – memory – mapped access – speed and code density.	**8**
UNIT-3	**Interrupt Service Routines:** Interrupt Service routines – Watch dog timers – Flash memory Basic toolset – Host based debugging – Remote debugging – ROM emulators – logic Analyzer – Caches – Computer optimisation – Statistical profiling.	**8**
UNIT-4	**In Circuit Emulators:** In circuit emulators – Buller proof run control – Real time trace – Hardware break points – Overlay memory – Timing constraints – Usage issues – Triggers.	**8**
UNIT-5	**Testing of Embedded Systems:** Testing – Bug tracking – reduction of risks & costs – Performance – Unit testing – Regression testing – Choosing test cases – Functional tests – Coverage tests – Testing embedded software – Performance testing – Maintenance.	**8**

Textbooks

1. Arnold S. Berger," Embedded System Design ", CMP books, USA 3rd Edition, (2002)
2. Sriram Iyer," Embedded Real time System Programming", 2nd Edition, TMH (2003).

Reference Books

1. Arkin, R.C," Behaviour-based Robotics", The MIT Press, 2nd Edition, (1998).
2. Embedded/ real-time systems: concepts, design and programming black book, Prasad, K V K K, Dreamtech press, New Delhi, 2nd Edition, (2003). Herma K., "Real Time Systems – Design for distributed Embedded Applications", Kluwer Academic, (1997).

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Understand and describe the phases of the embedded system design life cycle, including product specification, hardware/software partitioning, integration, and testing.
CO2	Analyze and make informed decisions on hardware/software partitioning, considering system performance, memory organization, and start-up behavior.
CO3	Implement and manage interrupt service routines, watchdog timers, and utilize memory-mapped I/O effectively in embedded systems.
CO4	Use debugging tools such as in-circuit emulators, logic analyzers, ROM emulators, and apply real-time trace and profiling techniques for embedded software optimization.
CO5	Apply appropriate testing methods such as unit testing, regression testing, and performance testing to ensure functionality, reduce risk, and support maintainability in embedded systems.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: SECOND

COURSE TITLE: ADVANCED JAVA PROGRAMMING		
Sub Code: MRAI202	**No of Credits : L-T-P-SS 3:0:2:0=4**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. To understand the basic concepts and fundamentals of platform independent object-oriented language.
2. To demonstrate skills in writing programs using exception handling techniques and multithreading.
3. To understand streams and efficient user interface design techniques.

#	CONTENTS	Hrs
UNIT-1	**JAVA BASICS:** Review of Object-oriented concepts, History of Java, Java buzzwords, JVM architecture, Data types, Variables, Scope and lifetime of variables, arrays, operators, control statements, type conversion and casting, simple java program, constructors, methods, Static block, Static Data, Static Method String and String Buffer Classes, Using Java API Document.	**7**
UNIT-2	**INHERITANCE AND POLYMORPHISM:** Basic concepts, Types of inheritance, Member access rules, Usage of this and Super keyword, Method Overloading, Method overriding, Abstract classes, Dynamic method dispatch, Usage of final keyword. **PACKAGES AND INTERFACES:** Defining package, Access protection, importing packages, Defining and Implementing interfaces, and Extending interfaces. I / O STREAMS: Concepts of streams, Stream classes-Byte and Character stream, reading console Input and Writing Console output, File Handling.	**9**
UNIT-3	**EXCEPTION HANDLING:** Exception types, Usage of Try, Catch, Throw, Throws and Finally keywords, Built- in Exceptions, Creating own Exception classes. **MULTI THREADING:** Concepts of Thread, Thread life cycle, creating threads using Thread class and Runnable interface, Synchronization, Thread priorities, Inter Thread communication..	**8**
UNIT-4	**AWT CONTROLS:** The AWT class hierarchy, user interface components- Labels, Button, Text Components, Check Box, Check Box Group, Choice, List Box, Panels – Scroll Pane, Menu, Scroll Bar. Working with Frame class, Colour, Fonts and layout managers. **EVENT HANDLING:** Events, Event sources, Event Listeners, Event Delegation Model (EDM), Handling Mouse and Keyboard Events, Adapter classes, Inner classes.	**8**
UNIT-5	**SWINGS:** Introduction to Swings, Hierarchy of swing components. Containers, Top level containers - JFrame, JWindow, JDialog, JPanel, JButton, JToggleButton, JCheckBox, JRadioButton, JLabel,JTextField, JTextArea, JList, JComboBox, JScrollPane. **APPLETS:** Life cycle of an Applet, Differences between Applets and Applications, Developing applets, simple applet.	**8**

Practical Component of IPCC

SINO	Experiments
1	Write a Java program to understand how to accept input using Scanner or Buffered Reader and print output using System.out.println statement.
2	Write a Java program to display the default value of all primitive data types in Java.
3	Write a java program to test whether string is palindrome or not
4	Write a java program to count number of alphabets, digits, special symbols, blank spaces and words from the given sentence.
5	Write a java program to count number of vowels and consonants from the given strings.
6	Write a Java program to demonstrate Method overloading

Textbooks

1. Herbert schildt (2010), The complete reference, 7th edition, Tata Mc graw Hill, New Delhi

Reference Books

1. T. Budd (2009), An Introduction to Object Oriented Programming, 3rd edition, Pearson Education, India.
2. J. Nino, F. A. Hosch (2002), An Introduction to programming and OO design using Java, John Wiley & sons, New Jersey.
3. Y. Daniel Liang (2010), Introduction to Java programming, 7th edition, Pearson education, India.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Understand the fundamentals of Java programming including object-oriented concepts
CO2	Apply object-oriented principles such as inheritance, polymorphism, method overloading/overriding
CO3	Develop Java programs involving packages, exception handling, file I/O operations, and multithreading
CO4	Create GUI-based applications using AWT and Swing components, event-driven programming
CO5	Design and implement Java applets and demonstrate the applet lifecycle

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026
SEMESTER: SECOND

COURSE TITLE: COMPUTER NUMERICAL CONTROL (CNC) MACHINES AND ADAPTIVE CONTROL		
Sub Code: MRAI213A	**No of Credits: L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. Students will be able to enumerate the anatomy of CNC & DNC machines, control systems and auxiliary systems
2. Illustrate the Constructional features, tooling system and Write Appropriate CNC Part Program for a given part
3. Elaborate the Actuations system & Interpolators of CNC machine tools
4. Comprehend the End Effectors and Machine Vision Technology
5. Review Lyapunov Analysis and Adaptive Control system for CNC Machines

#	CONTENTS	Hrs
UNIT-1	**CNC Technology:** An overview: Introduction to NC/CNC/DNC machine tools, Classification of NC /CNC machine tools, Advantage, disadvantages of NC /CNC machine tools, Application of NC/CNC. DNC systems: Classifications, Merits, Demerits and application.	**7**
UNIT-2	**Design of CNC:** Constructional features of NC/CNC machine tools, C.N.C. tooling and fixturing system, Designation of axis in CNC systems. Part programming: CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc..),	**8**
UNIT-3	**System Drives and devices:** Hydraulic and pneumatic motors, and their features, Electrical motors AC/DC and their features. Interpolators: Hardware Interpolators, Software Interpolators, NC/CNC controllers. Latest developments: Machining center, Turing center, Communication networking, recent developments of CNC systems, Virtual NC systems.	**8**
UNIT-4	**END EFFECTORS:** Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. **MACHINE VISION:** Functions, Sensing and Digitizing- imaging, Devices, Lighting techniques, Analog to digital single conversion, image storage, Image processing and Analysis-image	**8**
UNIT-5	Review of Lyapunov analysis, model Reference Adaptive Control, Composite Adaptation, Parameter Convergence: Persistency of Excitation /Uniform Complete Observe-ability, Adaptive Control in the Presence of Input Constraints, Direct MRAC for Nonlinear systems with Matched Structured Nonlinearities, Robustness of MRAC: Parameter Drift, Adaptive Control in the Presence of Uniformly Bounded Residual Nonlinearity, Disturbance Rejection, Input-to-State Stability, fast adaptation.	**9**

Textbook/ Textbooks

1. Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill International, Singapore, 2006
2. John Stenerson and Kelly Curran, Computer Numerical Control: Operation and Programming, PHI,

New Delhi, 2009,

Reference Books

1. TC Chang, RA Wysk and HP Wang, Computer Aided Manufacturing, PHI, New Delhi, 2009

Web links and Video Lectures (eResources):

- https://nptel.ac.in/courses/112102103
- https://nptel.ac.in/courses/112105211

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Understand the fundamentals of NC, CNC, and DNC machine tools,
CO2	Analyze the design and constructional features of CNC machines, tooling systems, axis configurations
CO3	Explain the working principles and characteristics of system drives
CO4	Evaluate the function and design of robotic end effectors and grippers
CO5	Apply concepts of machine vision and adaptive control

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: SECOND

COURSE TITLE: SIGNAL PROCESSING		
Sub Code: MRAI213B	**No of Credits: L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

- Illustrate digital signals, systems and their significance.
- Analyse the digital signals using various digital transforms DFT, FFT etc.
- Design and develop the basic digital system

#	CONTENTS	Hrs
UNIT-1	**Basic elements of digital signal Processing:** Concept of frequency in continuous time and discrete time signals –Sampling theorem – Discrete time signals. Discrete time systems –Analysis of Linear time invariant systems –Z transform –Convolution and correlation.	**8**
UNIT-2	**Introduction to DFT:** Efficient computation of DFT Properties of DFT – FFT algorithms – Radix-2 and Radix-4 FFT algorithms – Decimation in Time – Decimation in Frequency algorithms – Use of FFT algorithms in Linear Filtering and correlation.	**8**
UNIT-3	**Structure of IIR:** System Design of Discrete time IIR filter from continuous time filter – IIR filter design by Impulse Invariance. Bilinear transformation – Approximation derivatives – Design of IIR filter in the Frequency domain.	**8**
UNIT-4	**FIR filters:** Linear phase filter – Windowing techniques – rectangular, triangular, Blackman and Kaiser windows – Frequency sampling techniques – Structure for FIR systems.	**8**
UNIT-5	**Finite word length effects in FIR and IIR digital filters:** Quantization, round off errors and overflow errors. Multi rate digital signal processing: Concepts, design of practical sampling rate converters, Decimators, interpolators. Poly phase decompositions.	**8**

Textbook/ Textbooks

1. Oppenheim A V and Sehafer R W, "Discrete Time Signal Processing", Prentice Hall (2009), III Edn
2. Proakis J G and Manolakis D G, "Digital Signal Processing", Pearson Education India. (2007), IV Edn

Reference Books

1. Sanjit K Mitra "Digital Signal Processing" McGraw Hill Education, (2013), IV Edn
2. DeFatta D J, Lucas J G and Hodgkiss W S, "Digital Signal Processing", J Wiley and Sons, Singapore, (1995), II Edn
3. Ifeachor and Jervis, "Digital Signal Processing", Pearson Education India, (2002), II Edn

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Understand and analyze discrete-time signals and systems, including the concepts of sampling
CO2	Apply the Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) algorithms
CO3	Design IIR digital filters from analog prototypes using techniques
CO4	Design FIR digital filters using windowing methods
CO5	Evaluate the effects of finite word length in DSP systems, and apply multirate signal processing

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

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ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026
SEMESTER: SECOND

COURSE TITLE: COMPUTER INTEGRATED MANUFACTURING		
Sub Code: MRAI213C	**No of Credits: L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. Practicing design and implementation of computer integrated manufacturing systems through the application of the fundamental knowledge and skills of Mechanical Engineering
2. Use analytical reasoning to identify issues or problems and evaluate evidence in order to make informed decisions
3. Create knowledge in Smart systems and impart the source of concepts and techniques, which have recently been applied in practical situation.
4. Gives a framework of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering
5. Reason quantitatively as required in various fields of interest and in everyday life

#	CONTENTS	Hrs
UNIT-1	**Fundamentals of Manufacturing and Automation** Concept of Automation, Evolution of Industrial Automation, Reasons for automation, Automation Strategies, Levels of automation and USA Principle, Manufacturing & Production, Types of production, Functions in Manufacturing, Organization and information processing in manufacturing, Plant layout, Mathematical models of production systems, Methods of work part transport, transfer mechanisms and Buffer storage.	**8**
UNIT-2	**Material Handling and Storage and Line Balancing** Functions, types of material handling, analysis of material handling, design of system, AGVs, storage system performance, AS/RS, Carousel storage system, work-in-process storage, interfacing handling and storage with manufacturing. The assembly process, Assembly systems, manual assembly systems, methods of Line balancing& line balancing problems, design of automated assembly, types, parts feeding devices, analysis of single station and multi-station assembly machines.	**8**
UNIT-3	**Smart Communication Systems** Information, Mobility, Communication Technologies, Protocols, Cyber Physical Systems – the next generation of Embedded Systems and Networks, IT and OT convergence, co-creation and collaboration enablement. Smart Cloud- Hyper scale Computing; Intelligent Analytics Services. Smart Applications: Online Predictive Modeling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes; Smart Energy Management of manufacturing processes and facilities.	**8**
UNIT-4	**Smart Manufacturing** Smart manufacturing and connected enterprise, ISA 95, Functional and physical sub-divisions, Global connected supply chain, mass customization, customer co-creation. Factories of Future: The role of Artificial Intelligence in the factory of the future, Features of Experts systems, applications in	**8**

	manufacturing planning and control – Intelligent systems. Scheduling in manufacturing – scheduling the shop floor – Diagnosis & trouble shooting.	
UNIT-5	**Machine-to-Machine Communication (M2M)** Introduction to M2M and its Key features, Architecture and components of M2M, Requirements and Issues/concerns in M2M, Standardization Efforts and Applications of M2M, Smart Cards in M2M Communication and Smart Card Properties for M2M environments.. Developing IoT Solutions: Introduction to Python and different IoT tools, Implementation of IoT with Arduino and Raspberry, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT.	**8**

Textbook/ Textbooks

1. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Education, New Delhi. ISBN: 0132393212
2. Xu X, "Integrating Advanced Computer-Aided Design, Manufacturing, and Numerical Control", Information Science Reference

Reference Books

1. F Cecelja, "Manufacturing Information and Data Systems", Butterworth Heinemann, 2018
2. Jan Holler, Catherine Mulligan, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", Academic Press, 2019

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Understand the fundamental concepts of automation
CO2	Analyze material handling and storage systems, including AGVs, AS/RS, carousel systems
CO3	Explore the role of smart communication systems, cyber-physical systems, and intelligent analytics
CO4	Explain the concept of smart manufacturing, the use of AI and expert systems in planning and control
CO5	Evaluate machine-to-machine (M2M) communication architecture and standards, and develop IoT-based solutions using platforms

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026
SEMESTER: SECOND

COURSE TITLE: INDUSTRIAL AUTOMATION		
Sub Code: MRAI214A	**No of Credits: L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

- Understand automation technologies and identify advantages, limitations and applications of the same
- Develop ability to recognize, articulate and solve industrial problems using automation technologies
- To expose to various control techniques employed in process automation.
- To develop automation system for manufacturing and process industries.
- To expose the students to more advanced, precise and complex instrumentations which are being employed in the automation industry

#	CONTENTS	Hrs
UNIT-1	**AUTOMATION USING HYDRAULIC SYSTEMS** Hydraulic Systems, design aspects of various elements of hydraulic systems such as pumps, valves, filters, reservoirs, and accumulators and their selection. Practical case studies on hydraulic circuit design and performance analysis. Servo valves, hydraulic servo actuators, electro-hydraulic servo-valves, proportional valves, and their applications.	**8**
UNIT-2	**AUTOMATION USING PNEUMATIC SYSTEMS** Pneumatic fundamentals, control elements, position and pressure sensing, logic circuits, switching circuits, fringe conditions modules, sequential circuits - cascade methods - mapping methods – step counter method, and compound circuit design & combination circuit design. Pneumatic equipment - selection of components, design calculations, application, fault-finding, and hydro-pneumatic circuits.	**8**
UNIT-3	**CONTROL TECHNOLOGIES IN AUTOMATION** Industrial Control Systems, process industries versus discrete-manufacturing industries, continuous versus discrete Control. Computer-based control process and its forms. Open and closed-loop control system. Control system components. Introduction to sensor technology, various sensors, transducers, and signal processing. Programming of microprocessors using 8085 instructions.	**8**
UNIT-4	**ASSEMBLY SYSTEM AND LINE BALANCING** Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines. Automated material handling: Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems. Automated storage systems: Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.	**8**
UNIT-5	**INTRODUCTION TO ROBOT TECHNOLOGY & MODELING AND SIMULATION FOR MANUFACTURING PLANT AUTOMATION** Robot classification, robot elements, Robot co-ordinate systems, Position, path and speed control systems, robot programming for foundry, presswork, and machining. Collisions free motion planning. Introduction/ need for system Modeling, Building Mathematical Model of	**8**

	a manufacturing plant, Modern Tools- Use of Fuzzy decision making and Artificial Neural Networks in manufacturing automation, AI in manufacturing systems	

Textbook/ Textbooks

1. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing" Pearson, Education, New Delhi. ISBN: 0132393212
2. Antony Esposito, "Fluid Power with Applications" Pearson Education India. ISBN:8177585800
3. Andrew Parr, " Hydraulic and Pneumatics ", Butterworth-Heinemann. ISBN:0750644192

Reference Books

1. Bolton. W. "Pneumatic and Hydraulic Systems" Elsevier Science & Technology Books. ISBN:0750638362
2. N. Viswanandham, Y. Narhari "Performance Modeling of Automated Manufacturing Systems", Prentice- Hall. ISBN: 0136588247
3. W Bolton., "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" Prentice-Hall. ISBN: 0131216333
4. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall of India, New Delhi. ISBN: 8120309871.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Understand the components and design principles of hydraulic systems
CO2	Analyze pneumatic control systems, including logic circuits, sequential control methods
CO3	Evaluate industrial control technologies, distinguish between discrete and process control systems
CO4	Design efficient assembly systems and balanced production lines, and integrate automated material handling
CO5	Apply robot programming and modeling techniques in plant automation, using modern tools such as artificial intelligence

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026
SEMESTER: SECOND

COURSE TITLE: MACHINES & MECHANISMS		
Sub Code: MRAI214B	**No of Credits: L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

- For a given problem, Students will be able to classify different types of mechanisms, kinematic pairs.
- For a given case study, students will be perform velocity and acceleration analysis.
- Students will be able analyse static forces for various mechanisms with inverse dynamic analysis.
- Students will be able to demonstrate equation of motion and acceleration equation for different planar mechanisms.
- For a given application, students will be independently analyse Euler's dynamic equations for pure rotation.

#	CONTENTS	Hrs
UNIT-1	**Basics of Mechanisms:** Links, kinematic pairs, kinematic chain, mechanism and machine, schematic diagrams and description of common mechanisms like linkages, cams follower mechanisms, gear trains, belt and chain drives-no derivations, and multi-degrees of planar mechanisms in machines like earth moving machinery and planar versions of manipulators, mobility /degrees of freedom (DoF), Kutzbach's formula, determination of DoF of planar linkages and mechanisms with cam- follower pairs. Definition of position analysis problem, loop closure equations, derivation of solutions for simple mechanisms like fourbar, slider-crank,and multi DoF closed and open loop mechanisms, multiple branches of solution, exposure to graphical approach, inverse pose problem of an open loop 3R planar manipulator, and derivation of solution.	**8**
UNIT-2	**Velocity analysis:** Definition of the velocity analysis problem, angular velocity of a rigid link and relative velocity of points, analytical method of velocity analysis, derivation of equations and numerical solutions, forward and inverse velocity analysis of open loop 3R mechanism. Acceleration analysis: Definition of the acceleration analysis problem, angular acceleration of a rigid link and relative acceleration of points, Corioli's acceleration, analytical method of acceleration analysis and derivation of equations, numerical solution for simple mechanisms.	**8**
UNIT-3	**Static force analysis:** Free body diagrams, nature of joint reaction forces, static force analysis, application to simple linkages and cam-follower mechanisms. Inverse dynamic analysis: Definition of the inverse dynamic analysis problem, inertia forces and moments, equations of motion, derivation of equations of motion for planar mechanisms with single and multi DoF, D'Alembert's principle, virtual work principle and workless nature of constraint reaction forces, generalized coordinates and forces, derivation of equations using generalized coordinates and virtual work principle.	**8**
UNIT-4	**Forward Dynamic analysis:** Definition of the forward dynamic analysis problem, acceleration of links in terms of acceleration of independent coordinates, combining dynamic equations with acceleration equations, derivation of complete set of equations for single	**8**

	and multi DoF planar mechanisms, introduction to simulation of mechanisms	
UNIT-5	**Euler's equation for rigid body rotation:** Derivation of Euler's dynamic equations for pure rotation from Newton's laws, moments of inertia, principal moments and principal axes, representation of relative orientation of reference frames using rotation matrices, properties of rotation matrices, transformation of moments of inertia matrices from one reference frame to another, Euler's equations in principal reference frame, applications of Euler's equations	**8**

Textbook/ Textbooks

1. Ambekar A.G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007
2. Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press, 2003

Reference Books

1. Rao.J.S. and Dukkipatti R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi, 1992
2. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low Prices Student Edition,1999.
3. V.Ramamurthi, Mechanisms of Machine, Narosa Publishing House, 2002.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Analyze the structure and motion of planar mechanisms using degrees of freedom and position analysis.
CO2	Perform velocity analysis of linkages and manipulators using analytical methods.
CO3	Apply acceleration analysis techniques including Coriolis acceleration in planar systems
CO4	Conduct static and inverse dynamic force analysis using free-body diagrams and virtual work
CO5	Formulate forward dynamic models and apply Euler's equations for rigid body rotation analysis

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: SECOND

COURSE TITLE: ALGORITHMS & COMPLEXITY		
Sub Code: MRAI214C	**No of Credits: L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

- Students will be able to analyze the efficiency of sorting and searching algorithms.
- To determine whether there is a more efficient way of solving a problem.
- Write efficient algorithms and data structures for a variety of fundamental problems
- Conduct formal reasoning about problem complexity and algorithmic efficiency
- Recognize the design techniques of standard algorithms, and apply these techniques to develop new computational solutions to problems.

#	CONTENTS	Hrs
UNIT-1	**Introduction:** Network Flows, Residual Networks, Maxflow-Mincut, The Ford–Fulkerson Algorithm, Slow Example, The Edmonds–Karp Algorithm, Bipartite Matching, Image Segmentation.	**8**
UNIT-2	**Linear Programming:** Introduction, Linear Programming, Linear Algebra: Method of Substitution, Linear Algebra: Gaussian Elimination, Convexity, Duality, Linear Programming Formulations, The Simplex Algorithm, The Ellipsoid Algorithm.	**8**
UNIT-3	**Randomized Data Structures and Algorithms:** Basic Data Structures (Lists and Trees, Sorting and Searching, Hash tables and Universal Hashing), Basic Probability Theory and Algorithm Analysis. Algorithms (Graphs and Graph Algorithms, Design – Divide-and-Conquer, Greedy, and Dynamic Programming). Basic Probability Theory.	**8**
UNIT-4	**Approximation and Distributed Algorithms, Complexity Theory:** Basic Complexity Theory (Complexity Classes P and NP, NP-hardness and reductions, Basic notions of a Turing machine). Algorithmic techniques in distributed computing.	**8**
UNIT-5	**Streaming, Social Networks, Number Theory & Cryptography. Game Theory & Applications:** Basic understanding of online social networks; Algebra (Groups); Number Theory (Modulo Arithmetic, Prime Numbers). Probability Theory (Markov Chains), Basic Probability Theory.	**8**

Textbook/ Textbooks

1. J Kleinberg, E Tardos, *Algorithm Design*, Addison-Wesley
2. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran., *Fundamentals of Computer Algorithms*, University Press

Reference Books

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, *Introduction to Algorithms*, MIT Press
2. M. T. Goodrich and R. Tommassia, *Algorithm Design*, Wiley

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	Understand and apply network flow algorithms including Ford–Fulkerson and Edmonds–Karp for solving flow-related problems.
CO2	Formulate and solve linear programming problems using simplex, ellipsoid, and duality concepts.
CO3	Implement and analyze randomized algorithms and data structures using probability theory and algorithmic design techniques.

CO4	Explore complexity classes, NP-hardness, and design approximation and distributed algorithms using Turing machine concepts.
CO5	Apply algorithmic methods in modern domains such as social networks, number theory, cryptography, and game theory.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**3**		**2**
CO2		**2**	**1**	**3**	
CO3	**3**		**1**	**2**	
CO4		**3**		**1**	**2**
CO5	**2**		**3**		**1**

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: SECOND

COURSE TITLE: AUTONOMOUS VEHICLES & AI LABORATORY		
Sub Code: MRAIL206	**No of Credits: L-T-P-SS 0:0:2:0=2**	**No. of Lecture hours/week :01**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

- Program Miniature Self Driving Cars using Python
- Capture images from onboard camera, detect objects/colors/traffic signs and autonomously navigate o road
- Apply AI & ML concepts for autonomous navigation of self-driving cars
- Simulate traffic accidents, investigate them via data analysis and reconstruction

Sl.NO	Experiments
1	Introduction to Python Programming • Explore fundamental Machine Learning (ML) and Artificial Intelligence (AI) concepts • Master printing, doing math operations and creating variables in Python • Learn how to program the Auto Auto car to drive • Program Auto Auto to capture real-time information through the on-board cameras
2	Condition Execution • Learn about data types in Python • Get familiar with image processing and how pixels and the RGB scale work • Use If-else statements for conditional code execution
3	Control Structures • Develop an algorithm using if-elif-else statements to manage car responses when detecting • different traffic lights colors • Master using the "In" operator
4	Looping Structure • Image classification in machine learning, and the Haar algorithm for detecting stop signs • Master creating lists in Python • Running the same block of code multiple times • Developing object-avoidance algorithms using while loops to keep scanning for and respond to pedestrians and stop signs
5	AI & ML • Train a Neural Network to Drive Your Car • Train a Neural Network using the data you previously collected • Deploy your trained model to your car • Test (and if necessary, diagnose) your model • Accident reconstruction o Write a "black box" script to collect and store sensor data o Simulate traffic accidents for later data analysis and reconstruction

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: SECOND

COURSE TITLE: MINI-PROJECT WITH SEMINAR		
Sub Code: MRAIM25	**No of Credits: L-T-P-SS 0:0:0:3=3**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE OBJECTIVES:

1. To support independent learning.
2. To guide to select and utilize adequate information from varied resources maintaining ethics.
3. To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
4. To develop interactive, communication, organisation, time management, and presentation skills.
5. To impart flexibility and adaptability.
6. To inspire independent and team working.
7. To expand intellectual capacity, credibility, judgement, intuition.
8. To adhere to punctuality, setting and meeting deadlines.
9. To instil responsibilities to oneself and others.
10. To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini Project with Seminar: This may be hands-on practice, survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar, shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question-and-Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester. **There is no SEE for this course**

Prepare the report according to standard template provided by College or University,

Course outcomes:

At the end of the course the student will be able to:

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

ADMISSION YEAR: 2025-2026 ACADEMIC YEAR: 2025-2026

SEMESTER: SECOND

COURSE TITLE: GUIDELINES FOR ONLINE/MOOC/ABILITY ENHNACEMENT/AUDIT COURSES		
Sub Code: 22AUD27/22AEC27	**No of Credits: L-T-P-SS 0:0:0:0=0**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**

COURSE LEARNING OUTCOMES

Students will be able to:

- Understand and recall the concepts in the corresponding subjects.
- Explain concepts using their own words; produce a summary of what they have learned as a test of this ability.
- Apply the concept learnt in solving the assignments questions by searching in websites and submit in Learning management System (LMS).
- Improve communication skills, the participation skills students learn within their online courses translate to many professions, including creating and sharing documents, incorporating audio/video materials into assignments, completing online training sessions, etc
- Provide examples explicating course content, work in groups to find or develop examples from their own lives that further explain core content instead of relying on the instructor.

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs. **Ability Enhancement Courses**:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialisation as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.